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ABSTRACT

Research has provided inadequate scientific basis for incorporating fundamental motor skills into the curriculum. More knowledge on how children acquire motor skills is imperative. Motor development of a child is generally viewed as an inherent sequential process of motor unfolding, while skill acquisition is the process mediated through practice, training, and the associated learning mechanisms. The development of motor skills in infants and children is largely the result of growth and maturation. Three major factors that should be considered by the practitioner teaching physical skills are the state of the learner, the nature of the skill, and the methods of instruction. Sex differences are not apparent in the rate of acquisition of basic skills. There is also little evidence to show that the rate of skill acquisition is any slower or faster in young children as compared to more mature learners. It is important to the success of learning to maintain an optimal arousal level throughout the acquisition level. Skills described as continuous are generally learned more rapidly than discrete skills. The best methods of instruction that can be employed by the practitioner are those based on a complete knowledge of the nature of the learner, the nature of the skill, and the quality and amount of practice given. Knowledge of results also qualifies as a most important factor in skill acquisition. Practitioners and researchers are doing a better job now than in the past. Efforts should be concentrated not on producing more highly skilled youthful athletes but on producing a larger number of adequately skilled children. (SK)

WHAT RESEARCH TELLS THE PRACTIONER ABOUT SKILL ACQUISITION

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The acquisition of motor skills is a continuous process beginning before birth in the womb and proceeding well into old age. In a broad sense the simplest or most undirected muscular contractions of the infant are a form of physical practice which ultimately leads to more purposeful refined movements and skills. In a meaningful discussion of motor skill acquisition in pre-school and early elementary aged children, a more specific definition of what is meant by motor skill acquisition must be given. A clear distinction must be made between motor development and skill acquisition. Also, any research interest in the acquisition of motor skills must necessarily specify what is a skill so that the processes which act to bring about its occurrence can be accurately determined.

Motor development of a child is "generally viewed as an inherent sequential process of motor unfolding" (Malina, 1974). Motor development is seen to emerge independently of learning. Formal instruction, training, or practice are not prerequisites. The motor behaviors observed arise as a consequence of the maturation of certain neural tissues, growth of the bones and muscles, and an overall genetically preprogrammed increase in the complexity of the organism.

Skill acquisition may be distinguished from motor development. It should be viewed as a process mediated through practice, training, and the associated learning mechanisms. It is a process which is primarily influenced by the nature and structure of the environment. One observes the development of motor skills and teaches or otherwise provides for the acquisition of motor skills.

Motor development research has been carried out over the years in order to clarify and organize the common motor characteristics which children exhibit at various ages; a behavioral observation approach. Less is known about how these changes come about. Fundamental movement patterns largely in the form of reflex behaviors, the tonic neck reflex, for example, have been identified and associated with specific age levels. Such patterns are the precursors of the fundamental motor skills which in turn are the forerunners of sports skills and other complex learned motor skills. Prehension (grasping) and upright locomotion are two major developmental tasks of infancy. Stott (1967) aptly makes the point that there probably are no more advanced motor skills which do not bear some relation to one or both of these tasks.

Fundamental motor skills, well defined in the literature (DeOreo, 1974, Wickstrom, 1970) develop naturally through maturation and growth. We are all familiar with the fundamental motor skills of walking, running, hopping, jumping, and throwing. Since the development of these skills is primarily genetically determined, they too, are observed to occur at specific age levels. Through careful observation, often with the help of photography and video tape, a great deal of information is available to which fundamental motor skills can be assigned to the chronological ages at which they first occur. Indeed, it is often through the use of these motor development maps that abnormalities in children are detected and specific remedial programs instituted. Many publications document well the normal motor development of children. (Arnheim & Pestolesi, 1973; Bayley, 1941; Cratty, 1970;

Cratty & Margaert, 1969; Espenschade & Eckert, 1967; Keogh, 1973; Stott, 1967; Wickstrom, 1970). Thus, a good understanding of the natural appearance and development of fundamental motor skills has been gained from the sequential observation of maturing children.

The development of motor skills in infants and children is largely the result of growth and maturation. Research in the field is of a normative approach, whereby the basic questions asked concern when motor skills appear. Research into the skill acquisition process is also concerned with when skills may be taught, but more importantly, it is concerned with how the environment may be structured to bring about the occurrence of learned skilled behavior. The answers to the how are often best gained through experimental types of research.

By far the greatest amount of information about skill acquisition deals with adults or mature learners. If we can establish the similarities or differences in the skill acquisition process between children and adults then it becomes possible to generalize accurately from the greater body of literature. There is certainly no reason to expect that skill acquisition in children is governed by any dissimilar principles of learning. Too often we become overly interested in the actual performance outcomes, whether the ball goes through the hoop, and fail to examine closely the elements contributing to the overall control of the movement. As Keogh (1973) has pointed out, "it is important to watch the movements made by the child rather than watch the product of the child's movements" [p. 72]. For tasks which demand high levels of motor development and maturation

intensive study with children is pointless, unless their movement strategies and the degree of control they display become of primary emphasis. If an attempt is made to study the acquisition process simple tasks may often be used. Differences in the final quality of the movement outcomes may exist, but there may be similarities in rate of acquisition or the effects of various instructional techniques.

In looking closely at the limited amount of research literature dealing with motor skill acquisition in children it is important to ask the question why or in what ways do children acquire skills differently than adults. What differences do exist between immature and mature learners and what differences should we expect may exist? How may we alter our methods of teaching to increase our effectiveness with children?

Following an outline suggested by Stallings (1973), the three major factors that must be considered by the practitioner teaching physical skills are a) the state of the learner, b) the nature of the skill, and c) the methods of instruction. Although this outline was not developed exclusively with the young child in mind, it provides a good framework from which to work. Basic to the understanding of the role of each of these factors is a continual awareness of the interrelationships that exist between them. We examine them separately only to better understand how they interact to improve the level of performance of children. As practitioners we share a common goal; the desire to improve upon the movement capabilities of our students. Only when we can better analyze the nature of the students we teach, the methods we use, or the types of skills we expect students to

learn can we take steps to improve the oftentimes dismal results we experience.

To aid a child in the acquisition of skill as much as possible should be known about his physical makeup. However, the physical growth and maturation of a child cannot be accurately predicted from knowledge of his chronological age. In youngsters the degree of maturation determines to a large extent the degree to which a skill can be acquired, ~~if it can be acquired at all~~. There are no simple ways to identify and group children according to maturational status, and the correlations between physical growth factors such as height and weight and quality of skilled performance are usually low and ~~non-significant (Latchaw, 1954; Solley, 1957)~~. Skill acquisition in children is dependent upon the relative degree of maturation present in each child. ~~And, without~~ more exacting knowledge of the contribution ~~maturation makes~~, an important gap ~~exists~~ in how much we can infer ~~directly to a skill~~ acquisition process and to maturation itself. A problem of this ~~sort~~ is old and has plagued developmental research efforts for a long time.

It is known that in order for a child to learn a motor skill, a number of prerequisite maturational systems must be developed. With the development of the special senses, particularly the eyes and the proprioceptive or nerve muscle mechanisms, certain identifiable basic abilities emerge. When approaching a given skill the degree of proficiency found in the basic abilities determines to a large extent the rate and quality of learning. Various names are used to label basic abilities and distinguish

them from one another. To qualify as a basic ability each must be subject to measurement and be shown to change over time as a result of maturation or practice. Coming from several studies (Barry & Cureton, 1961; Ismail & Cowell, 1961; Rarick & Dobbins, 1975) the following list gives some idea of the prerequisite basic abilities in children needed for motor skill acquisition. Gross limb-eye coordination, fine visual-motor coordination, balance on the floor and on objects (static & dynamic), movement speed, and leg coordination represent some of the perceptual motor abilities identified. The physical abilities include muscular strength, power, and endurance; flexibility, body fat (dead weight), and strength to body weight ratio are also important. In the study of skill acquisition the presence of these abilities is needed. Inadequate development of, or lack of one or more of them reduces the probability that motor skills can be learned.

With respect to the acquisition of novel motor tasks resembling [illegible]ic abilities some generalizations can be made. The use of novel unpracticed tasks is necessary to help eliminate the confounding variable of previous practice experience. In four well done investigations no differences have been found in the rate of skill acquisition in arm speed in children ages 10 & 14 (Alderman, 1968), in discrimination arm movement time tasks in children aged 10 & 15 (Henry & Nelson, 1956) discrimination reaction time in children aged 8½, 11 & 16 (Noble, et. al., 1964), and dynamic balance acquisition on two gross motor tasks with subjects aged six to 26 (Bachman, 1961). Rate of learning it should be remembered is the amount of practice needed to reach a stable point in learning, a plateau or asymptote. Rate of learning can be seen through the comparisons of

typical learning curves which have been mathematically determined from the data of several age groups acquiring the same motor skill. The level at which each age group performs varies and is represented in the vertical axis. Rates of learning, however, are reflected by the similarity of the slope of the lines over time. Performance level or the quality of performance varies with age. It appears though, to vary independently of rate.

A second generalization from two of the above studies is that sex differences are not apparent in the rate of acquisition of basic skills. Gober & Hill (1970), in addition, have found no sex differences in reaction time and movement time of young children. Males and females appear to acquire novel tasks at the same rates. Differences in performance quality do exist, however. At the same ages Bachman (1968) found males to move more quickly than females. Overall he found that females balanced slightly better than males on the stabilometer but were inferior to the males on the ladder climb. Because rates of acquisition were essentially constant, the sex differences occurred through differences in initial ability. Such differences are expected and primarily caused by the different environmental pressures exerted on the sexes. Malina (1974), in a review of the motor development literature concludes that during early childhood (2-6 years), girls generally excell in tasks of jumping, hopping, rhythmic locomotion, and balance. Boys generally perform better in throwing and catching, and in tasks requiring strength and speed.

When adequate control is used, as in the preceding studies, there is little reason to expect that the rate of skill acquisition is any slower or faster in young children as compared to more mature learners. Children

acquire skills at approximately the same rates as adults but, because their entry levels and subsequent terminal levels of performance are inferior, we often conclude, erroneously, that they learn differently. Sex is not found to interact with rate of acquisition in children. When terminal differences are found in quality of performance in boys and girls of the same age, it is associated with advancing age. The supposed novel tasks used in research then become less novel to one sex or the other due to differences in histories of related movement experiences.

Another important aspect in understanding the nature of the young learner is his arousal level during skill acquisition. Quite generally this may be interpreted as motivation. The prevailing attitude expressed by research findings in the area is that some optimal level of arousal exists for the acquisition and performance of a motor skill. Success in learning is the result of being able to maintain an optimal arousal level throughout the acquisition process. Although little specific information exists with respect to optimal arousal response, particularly in children, that which is known is subject to logical interpretation.

The level of arousal exhibited in a skill learning situation is dependent upon a) one's own interpretation of the situation one faces and b) one's characteristic state of arousal or arousability. Past experience in the same or similar situations enables the mature learner to make more accurate interpretations of any given set of circumstances. Information, or perception of immediate surroundings, is gained essentially equally by young and old, but the meaning and interpretation of this information becomes more refined with age. Young children, then,

are less able to regulate their arousal toward an optimal point because they have had fewer past experiences to guide them. A characteristic arousal state on the other hand does not distinguish young from old. High trait anxiety as a measure of arousal is no more a characteristic of one age than another.

There is evidence in the research literature to support the contention that young children have greater difficulty maintaining their arousal states at optimal levels during skill acquisition. The presence of an audience was found more disruptive to preschool children than second graders learning a balance task (Crabbe, 1973). The preschoolers performed much better when alone, whereas the second graders did better with an audience. The presence of others, much like any novel environment, tends to increase arousal level. Managing arousal so that it maintains or improves performance is accomplished more easily by older children. Persistence at learning a task is also greater for older children (May, 1972) and may be attributed to their ability to maintain sufficient levels of arousal for longer periods of time. Children aged four and five who had histories of frequent social reinforcement from peers persisted longer in learning a motor skill (Clarke, et. al., 1974). It appears that richness in past experiences enables one to better interpret a learning situation and consequently adjust arousal level to facilitate acquisition. Young children have greater difficulty at doing this because of fewer experiences.

When teaching motor skills to young children it is important to remember that even a small change in surroundings, a new classmate, an observer, is sufficient to divert attention and increase arousal levels.

Not being able to adequately compensate, the child often displays erratic behaviors and may well miss important steps in the skill acquisition process. Excessive praise or reproof, competition, fear, etc., increase arousal level. The practitioner must be aware of the problems young inexperienced learners have in controlling their arousal levels. Through a greater awareness skill acquisition can be facilitated.

A closer look will now be taken at the nature of the skill and its role in the acquisition process. It should be recognized that the word skill has two definitions. Singer (1975) distinguishes between these meanings by describing skill as a particular act performed, such as catching a ball, or the manner in which the act is executed. Manner of execution denotes skill level and corresponds to quality of performance. Any motor task is a skill and need not be described with reference to quality of performance.

There is much to be gained by better understanding the nature of the skills we expect children to learn. Some skills require simple discrete movements which must be executed in an all or none fashion. Others are more complex requiring the chaining together of simpler parts into a smoothly performed whole, e. g., a trampoline routine. In some skills the environment is constantly changing forcing the performer to continually adjust his movements, e. g., intercepting a football. Through investigation of the relationships between the different "types" of skills and various instructional techniques, a few insights have been gained into the acquisition process.

Skills described as continuous such as bicycle riding or skating are generally learned more rapidly than discrete skills such as the tennis serve or typing. When the complexity of the skills is similar, not only are

continuous tasks learned more readily, but they are retained longer since repetitions of the movement are an inherent part of the skills (Stallings, 1973). Certainly the incorporation of rhythm into skills makes them more continuous, and thus more enduring (Cratty & Margaret,1969). Any attempt by the practitioner to form continuous skills from more discrete ones should enhance acquisition and/or retention.

Certain elements which underlie skilled performance have been identified. Depending on the nature of the skill, their importance in determining the quality of task execution varies. The common elements, however, should be specified so that contrasts can be made in skill level at various ages, and for modifications that may be made in the task for instructional purposes. The four most comprehensive elements are speed of movements required and the accuracy of these movements, form of the movements, and the adaptability of the performer under variable and unexpected situations. When differences are observed in quality of performance one or more of these elements may be held accountable. A simple generalization as to why children often appear less skilled than adults is that they may be slower, less accurate, more unorthodox, or less capable of adapting to the circumstances surrounding performance.

In more complex skills like those normally taught in the physical education curriculum, speed, accuracy, form, and adaptability interact to produce skilled performance. Unlike the simple tasks used in the experimental studies reviewed earlier stressing a single element of skill, a motor ability, sports and games demand a reasonable level of proficiency in all elements. The learner is not free to concentrate and direct his attention

to just one of the elements. He must effectively regulate the speed of his movements in order to maintain accuracy. Mechanical form must be appropriate if any degree of movement consistency is to be obtained. Skilled performance, then, requires the coordination of all the elements of a task. It is again emphasized that the process of skill acquisition does not come about through maturational changes but is learned. Therefore, the method of instruction and regulation of practice are the keys to the process and fall into the hands of the physical education teacher.

A skill may be classified according to the demands it makes on the learner. Self-paced skills allow the child to decide when to begin and at what rate of speed to progress. Form and response consistency are most important. Externally paced skills force the child to make decisions quickly and require perceptual and movement speed. Speed and accuracy of execution at the proper time are necessary. Externally paced skills should be altered, if possible, during first exposures so the child may better exert control over the speed and accuracy of his movements. Teaching a child to hit a ball from a batting tee before facing a pitcher is a good example.

Tudor (1975) selected a speed of movement task which required integration of a linear movement with a circular movement. The rate of acquisition of each separate component and the total amount learned was greater for a group of six year olds than for groups of 11 and 18 years olds. The six year olds, though, were unable to coordinate the two components into a well integrated whole. The correlations between speed of each of the components with practice actually lessened with the six year olds while increasing as

expected with the older children. Young children have well developed motor response mechanisms, but they have great difficulty in either inhibiting movements once they are initiated or controlling and directing their responses.

To teach motor skills effectively the practitioner must be aware of the inability of young learners to process the many perceptual and motor components of a task simultaneously. Any one or combination of the components may, however, be within the child's repertoire. The basic abilities needed to perform the skill can be present but chaining them together properly is not yet possible. Look at the variation in the quality of catching a ball. The speed, trajectory, and point of interception of the ball must be processed with additional information about the movement of the body and arms. With increasing age greater integration of all the information is seen to occur and results in a more refined catch. Kay (1969) points out that many times young children possess the correct responses but are unable to carry out the right actions at the right time. A time stress, characteristic of externally-paced tasks, is imposed by having to catch a ball at the proper time and place. The information processing ability of the young child is exceeded. When possible motor skills should be modified to allow emphasis on self-paced motor control.

The best methods of instruction that can be employed by the practitioner are those based on a complete knowledge of the nature of the learner, the nature of the skill, and the quality and amount of practice given. Too often there is insufficient time for giving adequate amounts of physical practice for complete skill acquisition due to large numbers of students and lack of facilities. It becomes doubly important given these circumstances to be sure the time available is spent wisely in the highest quality

of practice. Research and experience have elucidated several major practice and instructional considerations.

Youngsters in the typical physical education setting often fail to understand for what purpose they practice motor activities. Many have no real intent to learn because the goals of practice are unclear to them. It is the first responsibility of the practitioner to gain the attention of the learner and see that the goals of practice are understood. Visual demonstrations of the practice outcomes may be used with very young children making sure they take place within the limited visual field of the child (Cratty, 1973). Attention to the demonstration may be increased if a peer is used as the demonstrator. With older children a verbal description of the performance goal may suffice. In complex externally paced skills verbalization may be the only possible way to communicate proficiency goals effectively. Time spent making sure the child knows what is expected of him is critical to efficient skill acquisition. Children who can verbalize a task before performing it, a good instructional technique, show greater improvements in acquisition (Livesey & Little, 1971; Lombard & Stern, 1969).

The number and spacing of practice sessions is important in skill acquisition. Too often these factors are already determined for the practitioner and cannot be changed regardless of the type of learner or nature of the skills to be taught. Adequate rest is necessary to prevent physical and mental fatigue from interfering with acquisition. The distribution of practice time is more important with young children who should be given shorter and more frequent practice sessions. Such a procedure helps eliminate loss of interest and boredom, common problems with immature learners.

The child can be easily overwhelmed when a complex skill is introduced all at once. For this reason lead-up activity and task simplification are important instructional considerations. Many skills are broken down into component parts so that mastery of each part is expected before the whole skill is practiced. The principle which should guide the practitioner is to use the largest task unit possible making sure the learner fully comprehends it. Thus, in working with younger children and their reduced conceptual capabilities, more thought needs to be given to the size of the instructional unit. If a skill is practiced in parts the teacher must insure that the child constantly be aware of how the parts fit into the whole pattern of the skill (Lawther, 1968).

The impact that reinforcement has on motor skill acquisition is tremendous. There may, however be little difference in its potency among children and adults. Reinforcement is given in an effort to increase the probability one will continue practicing. It is important to, in some way, see that the effects of one's practice are recognized through a reinforcing circumstance. Success is an importnat reinforcer. Early success in skill acquisition often distinguishes the interested child intention acquiring additional skills from the less motivated one. The practitioner has many avenues through which to provide reinforcement and should do so freely.

Knowledge of results (KR) also qualifies as a most important factor in skill acquisition. Knowledge of results is that information provided to the learner during or after performance which allows him to determine the errors he made. Such information, then, helps improve the quality of

the next response or practice attempt. Although KR need not be provided by someone, it most often is for children. Thus, certain factors should be kept in mind when providing KR to youngsters. Contrary to popular belief the more immediate the KR is not always the best situation. Certainly, the delay between performance termination and KR should not be too great. But, allowing the learner to think for himself a moment about his performance before providing him with KR may well be a more effective learning condition. Children should be encouraged to do this. The detail or specificity of the KR given is important. With children, especially very young ones, detail in KR can be both confusing and meaningless. Early in practice children will benefit more from simply a right or wrong response, and specific details will become increasingly helpful with practice or in older learners.

In this paper much has been touched upon dealing with the acquisition of skill in children, but, there is truly little specific information available to answer so many very simple questions. As Seefeldt (1971) has pointed out ". . . research has provided on inadequate scientific basis for incorporating fundamental motor skills into the curriculum." [p. 20] Definitely, more knowledge about how children acquire motor skills is imperative. What information do we have concerning the influence of teaching style on rate of skill acquisition in children? Is the sex of the teacher important? The type of teacher you are and the way you personally relate to your students has to be a key factor in the learning of motor skills. What about the commonly accepted teaching methods, drill, problem solving, command to discovery, etc.? According to Lawther (1966) " . . . there are so many factors

affecting efficiency of methods that precise prescription of the best method is well nigh impossible . . . " [p. 68] There certainly seem to be no common methods among great teachers.

There is little doubt that we as practitioners and researchers are doing a better job now than in the past. We see higher levels of performance occurring at earlier ages every year. Our swimmers, gymnasts, and other athletes at the upcoming 1976 Olympics in Montreal will be the youngest ever, yet the most highly skilled. We should concentrate our efforts, I think, not so much to continue to produce more highly skilled youthful athletes, but to produce a larger number of adequately skilled children.

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